The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Mechanical Engineering

Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	**: DMX5572 -Materials and Manufacturing Technology**
Academic Year	: 2020/ 21
Date	: 22nd January 2022
Time	: 0930-1230hrs

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Eight (8)** questions.
3. Answer any **Five (5)** questions only. All questions carry equal marks.
4. Answer for each question should commence from a new page.
5. Relevant charts/ codes are provided.
6. This is a Closed Book Test (CBT).
7. Answers should be in clear handwriting.
8. Do not use Red colour pen.

QUESTION 01 (20 marks)

(a) With the aid of sketches, briefly explain complete solid solubility and partial solid solubility in alloys. **(4 marks)**

(b) The Fig. Q1 shows the part of the Iron-Carbon phase diagram. Using the phase diagram answer the following.

i. Label the phase/s in areas marked **1-5** in the phase diagram. **(5 marks)**

ii. A piece of plain carbon steel containing 0.3wt% of carbon is heated to 1000°C, and then uniformly cooled down to 650°C. State the phase changes taking place during cooling. **(5 marks)**

iii. Calculate the amounts of ferrite and austenite present at 750°C, containing 0.3 wt% carbon. **(6 marks)**

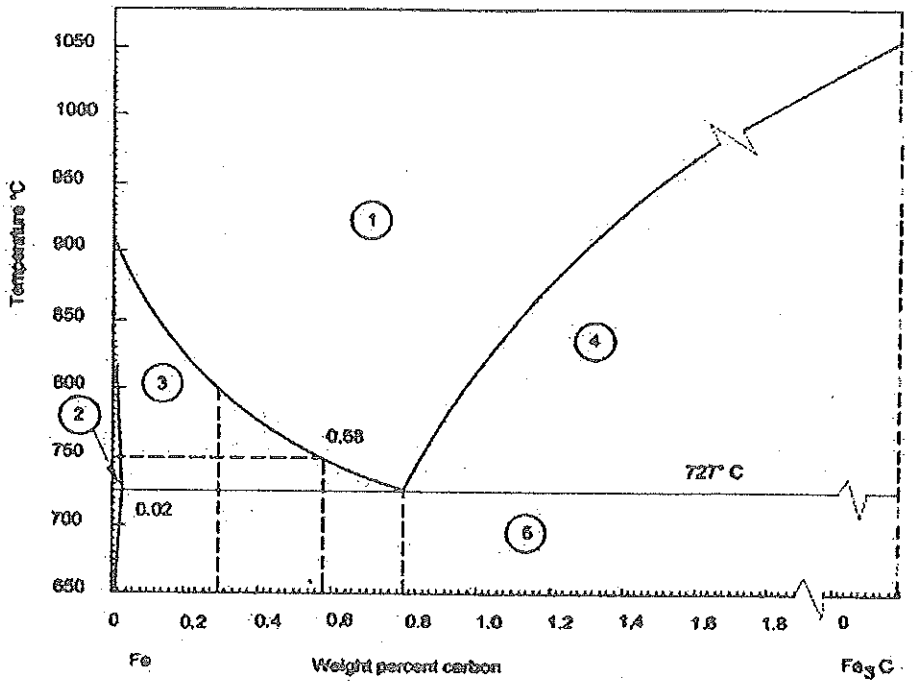


Fig. Q1

QUESTION 02 (20 marks)

(a) What is a copolymer? Discuss the types of copolymers available. **(6 marks)**

(b) Differentiate between Addition polymerization and Condensation polymerization. **(6 marks)**

(c) What are the six major mechanisms used to strengthen materials? Explain them briefly. **(8 marks)**

QUESTION 03 (20 marks)

(a) What is the difference between Hardness and Hardenability? **(4 marks)**

(b) A cylindrical component of diameter 62.5 mm will be made with alloy steel. The candidate materials are 8660, 8640, 8630 and 8620 alloys. The component will be austenized and quenched in moderately agitated water or oil and the surface and center hardness values must be at least 50 and 40 HRC respectively.

i. What is the carbon content in each of these 4 alloys? **(4 marks)**

ii. Determine the hardness values of these alloys at the surface and center, if they were quenched in moderately agitated water. Comment on which of the alloys satisfy the requirements. (Show your calculations. Refer Fig. Q3(a) (i) and Fig. Q3(b)). **(6 marks)**

QUESTION 04 (20 marks)

(a) Explain the significant differences between cold working and hot working. **(6 marks)**

(b) Explain the effects of cold working and hot working on strength and ductility of a material. Also, give examples for clod and hot working processes. **(6 marks)**

(c) Explain the law obeyed during the phenomena of strain-hardening, describing all parameters in the governing relationship. **(4 marks)**

(d) Explain the significance of dislocations in strain-hardening of a metal. **(4 marks)**

QUESTION 05 (20 marks)

(a) Distinguish between Bulk deformation processes and Sheet metal processes and give at least three examples for each process. **(10 marks)**

(b) *Spring back effect is commonly encountered in bending processes.* **(2 marks)**

(i) Explain the phenomenon of spring-back.

(ii)Briefly explain the way in which spring-back can be minimized. **(2 marks)**

(c) *Clearance between the blades of a shearing machine plays a significant role in shearing process of metal sheets.* **(6 marks)**
Explain with neat sketches, the consequences of incorrect clearance during the shearing process.

QUESTION 06 (20 marks)

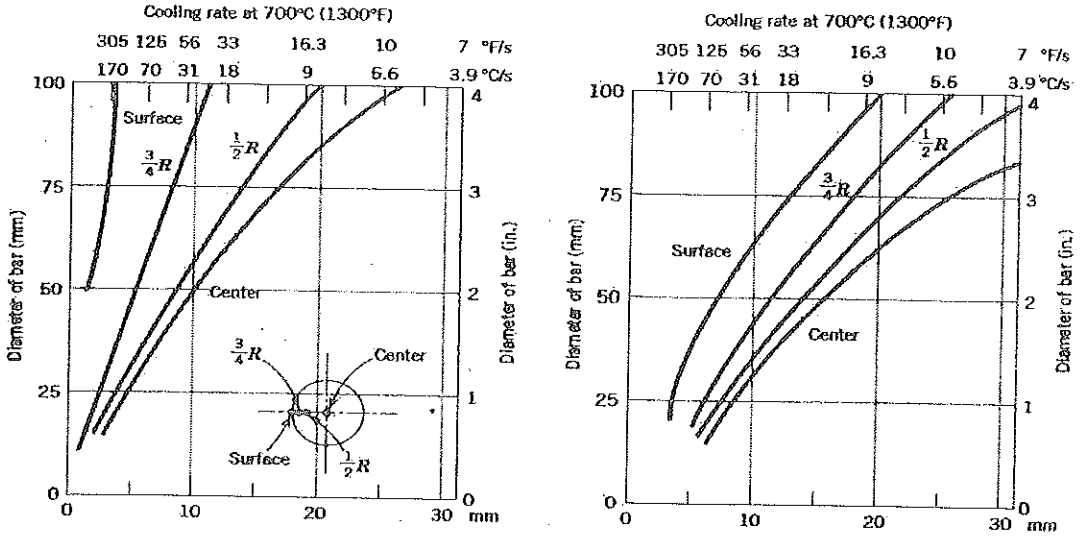
(a) What are the advantages and disadvantages of welding compared to other types of metal joining processes? **(5 marks)**

(b) What is the fundamental difference between a fusion welding process and a solid-state welding process? **(5 marks)**
Give examples for the above two types of welding processes.

(c) Describe the Ultra-sonic welding process and identify its major application areas. **(5 marks)**

(d) Briefly describe three common defects in welded joints. **(5 marks)**

ii. Determine the hardness of these alloys at the surface and center, if they were quenched in moderately agitated oil. Comment on which of the alloys satisfy the requirement. (Show your calculations. Refer Fig. Q3(a) (ii) & Fig. Q3(b)). **(6marks)**



(i) Water Quenching (ii) Oil QuenchingFig.Q3 (a) Cooling rate as a function of diameter at surface, three quarter radius(3/4R), mid radius (1/2R) and center positions for cylindrical bars quenched in moderately agitated (i) water and (ii) oil. Equivalent Jominy positions are included in bottom axis.

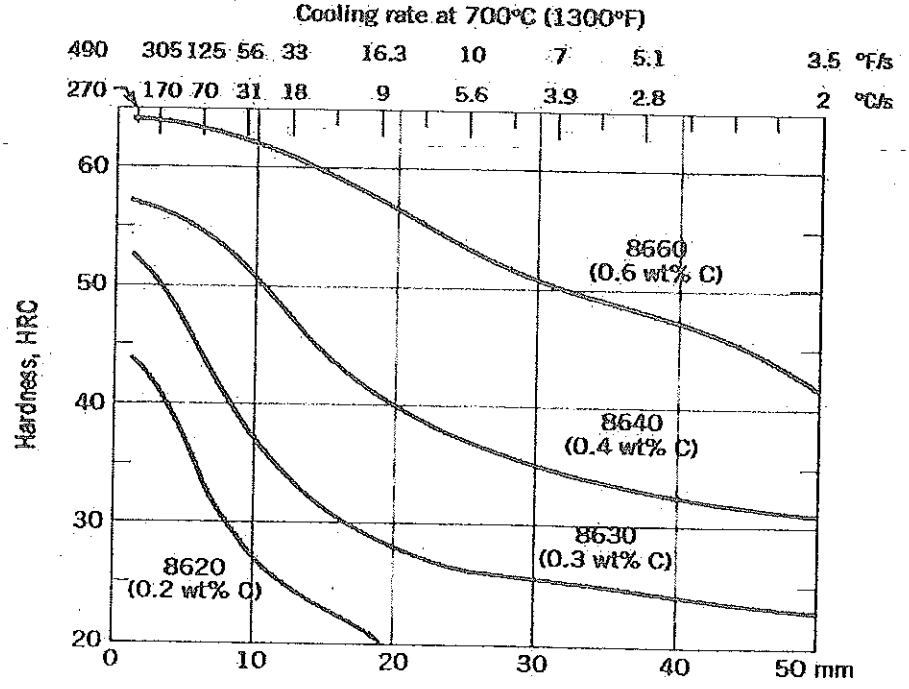


Fig. Q3(b) –Hardenability curves for four 8600 series alloys

QUESTION 07 (20 marks)

(a) List out the basic steps in casting process. **(5 marks)**

(b) Define shrinkage and porosity. How do you distinguish cavities in a casting formed due to porosity or to shrinkage? **(5 marks)**

(c) How does mould material influence the fluid flow and heat transfer? **(5 marks)**

(d) List out the common defects in metal casting. How do these defects influence the condition of the final product? **(5 marks)**

QUESTION 08 (20 marks)

(a) Briefly explain the importance of Metrology in the context of manufacturing engineering. **(5 marks)**

(b) What are the common types of errors encountered in Metrology? Briefly discuss the ways in which you would rectify these errors. **(5 marks)**

(c) Gauges are widely used in metrology, particularly in manufacturing of products. What makes gauges differ from other forms of measuring instruments? **(5 marks)**

(d) Standardization plays a significant role in the measurement of length. Discuss the importance of standardization in relation to measurement of length. **(5 marks)**